

Bridgeton Sanitary Landfill Ambient Air Response Alert Protocol
Department of Health and Senior Services
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Background and Purpose

The purpose of this document is to provide recommended response levels in order to assess monitoring data being generated by the Missouri Department of Natural Resources or their contractor for the Bridgeton Sanitary Landfill subsurface smoldering event response. Monitoring equipment being used includes AreaRAE monitors, an UltraRAE benzene monitor and a Jerome J-605 hydrogen sulfide monitor. In preparing this review, the Department of Health and Senior Services (DHSS) reviewed available comparison values (guideline concentrations) from the Environmental Protection Agency, Agency for Toxic Substances and Disease Registry and National Institute for Occupational Safety and Health. When determining appropriate guideline concentrations to choose, DHSS elected to choose the lowest appropriate and detectable guideline concentration available for each response level. Where the lowest guideline concentration was below the detection limit capability of an instrument, the lower detection limit of the monitoring instrument was chosen as the appropriate response trigger concentration. Any response decision triggered by monitoring results should be coordinated between responsible agencies and determined based on valid data, site conditions, meteorological conditions, planned site activities, and any other appropriate information. Below is a review of the four chemicals of concern for monitoring around the Bridgeton Sanitary Landfill, a summary table of available guideline concentrations reviewed (Table 1) and a table of response trigger concentrations (Table 2).

Hydrogen Sulfide

Concentrations ≥ 0.07 ppm

- DNR staff determine data validity and 30-minute average concentration
- If 30-minute average is ≥ 0.07 ppm (ATSDR's acute EMEG), coordinate "yellow" response

0.07 ppm - Inhalation - Acute - (ATSDR - Minimal Risk Level List)

Concentrations ≥ 0.3 ppm

- DNR staff determine data validity and 30-minute average concentration
- If 30-minute average is ≥ 0.33 ppm (EPA's 8-hr AEGL-1), coordinate "orange" response

- from EPA's Acute Exposure Guideline Levels

Concentrations ≥ 5 ppm

- DNR staff determine data validity and 10-minute average concentration
- If 10-minute average concentration is ≥ 5 ppm [half of NIOSH's 10-minute REL (10 ppm)], coordinate "red" response

- from NIOSH

**EPA's 8-hr AEGL-2 (long-term effect /serious short-term effect threshold) is 17 ppm.*

EPA's 10-minute AEGL-2 is 41 ppm.

**EPA's 8-hr AEGL-3 (life-threatening effect threshold) is 31 ppm.*

EPA's 10-minute AEGL-3 is 76 ppm.

Yellow and orange response levels: ATSDR's environmental media evaluation guide (EMEG) for acute (<14 days) inhalation exposure to hydrogen sulfide is a concentration not expected to pose a health threat to the general population, including sensitive individuals such as children and asthmatics. EPA's acute exposure guideline level-1 (AEGL-1) for eight hour exposure to hydrogen sulfide is a concentration above which the general public, including sensitive individuals, could experience transient, reversible symptoms such as discomfort and irritation. Both the EMEG and AEGL-1 are based on a study in which asthmatics exposed to 2 ppm hydrogen sulfide for 30 minutes developed headache and some measurable changes in lung function. ATSDR's EMEG was established for a longer exposure

period of up to 14 days and, as a more conservative value, may be more protective of sensitive individuals, including asthmatics and others with chronic respiratory disease.

Red response level: The NIOSH recommended exposure limit (REL) for hydrogen sulfide is an upper limit of exposure during a work-shift for prevention of any acute effects, especially on the respiratory and nervous systems. EPA's AEGL-2 values are concentrations above which the general public, including sensitive individuals, could experience serious short-term or long-lasting health effects. EPA's AEGL-3 values are concentrations above which the general public could experience life-threatening health effects. Although NIOSH's REL was established for worker exposure, it is the more conservative value and, therefore, was used to determine a red-level response value. The red-level response trigger of 5 ppm was determined by dividing the NIOSH REL in half. This would provide agencies with the ability to confer on the situation and act to help prevent exposures of public health concern should the need arise.

Sulfur Dioxide

Concentrations ≥ 0.1 ppm

- DNR staff determine data validity and 30-minute average concentration
- If 30-minute average concentration is ≥ 0.1 ppm (i.e., at least the lower detection limit of the monitoring instrument), coordinate "orange" response

Concentrations ≥ 0.3 ppm

- DNR staff determine data validity and 10-minute average concentration
- If 10-minute average concentration ≥ 0.375 ppm [half of AEGL-2 (0.75 ppm)], coordinate "red" response

- ✓ *ATSDR's acute EMEG is 0.01 ppm. *- Acute, inhalation (ATSDR MRL)*
- ✓ *NAAQS 1-hr average level is 0.075 ppm.
- ✓ *EPA's AEGL-1 is 0.20 ppm. *(10 min - 8 hr)*

NAAQS 24-hr average is 0.14 ppm.

*NIOSH REL is 2 ppm. ✓

*NIOSH STEL and OSHA's 8-hr PEL are 5 ppm. ✓

✓ *EPA's 8-hr AEGL-3 is 9.6 ppm.

✓ EPA's 10-minute AEGL-3 is 30 ppm.

Orange response level: ATSDR's EMEG for acute (<14 days) inhalation exposure to sulfur dioxide is a concentration not expected to pose a health threat to the general population, including sensitive populations such as children and asthmatics. The EMEG is based on a study in which especially sensitive asthmatics exposed to 0.1 to 0.5 ppm sulfur dioxide for 10 minutes while exercising exhibited slight increases in airway resistance. EPA's AEGL-1 is a concentration above which the general public, including sensitive individuals, could experience transient, reversible symptoms such as discomfort and irritation. NAAQS 24-hour and 1-hour average levels of exposure were established for the protection of public health, including the health of sensitive individuals such as children and asthmatics. Because the lower detection limit of the AreaRae sensor (0.1 ppm) exceeds the more conservative guidelines (the EMEG and 1-hour NAAQS) but not other protective comparison values (EPA's AEGL-1 and 24-hour NAAQS), the detection limit was chosen as a guideline for determining an orange-level response.

Note - Detection limit is above level of no effect

Red response level: EPA's AEGL-2 value is a concentration above which the general public, including sensitive individuals, could experience serious short-term or long-lasting health effects. The AEGL-2 is based on a study in which asthmatics exposed to 0.75 ppm sulfur dioxide while exercising (for 10 minutes to 3 hours) clearly exhibited significant increases in airway resistance. EPA's AEGL-3 values are concentrations above which the general public could experience life-threatening health effects. NIOSH recommended exposure limit (REL) and short-term exposure limit (STEL) and OSHA

permissible exposure limit (PEL) for sulfur dioxide are average upper exposure limits for workers in an occupational setting. The AEGL-2 is more conservative than either the STEL or PEL and may be the most protective comparison value for determining red-level response. The red-level response trigger of 0.375 ppm was determined by dividing the AEGL-2 in half. This would provide agencies with the ability to confer on the situation and act to help prevent exposures of public health concern should the need arise.

Benzene

Concentrations ≥ 0.05 ppm

- DNR staff determine data validity and 30-minute average concentration
- If 30-minute average concentration is ≥ 0.05 ppm (i.e., at least the lower detection limit of the monitoring instrument), coordinate "orange" response

Concentrations ≥ 0.5 ppm

- DNR staff determine data validity and 10-minute average concentration
- If 10-minute average concentration is ≥ 0.5 ppm [half of NIOSH's STEL (1 ppm)], coordinate "red" response

*ATSDR's EMEG is 0.009 ppm *-Acute inhalation (ATSDR MRL)*
*EPA's 8-hr AEGL-1 is 9 ppm.
EPA's 10-minute AEGL-1 is 130 ppm

*EPA's 8-hr AEGL-2 is 200 ppm.
EPA's 10-minute AEGL-2 is 2,000 ppm.

Orange response level: ATSDR's EMEG for acute (<14 days) inhalation exposure to benzene is a concentration not expected to pose a health threat to the general population, including sensitive individuals. The EMEG is based on an animal study in which immunological effects were observed in mice exposed to 2.5 ppm (human-equivalent concentration) benzene. EPA's AEGL-1 for exposure to benzene is a concentration above which the general public, including sensitive individuals, may experience transient, reversible symptoms. The AEGL-1 is based on a human study in which mild, subjective effects (specifically, nervous system effects such as dizziness) were not observed during 2-hour exposure to 110 ppm benzene. Because the lower detection limit of the benzene sensor (0.05 ppm) exceeds the most conservative guideline (ATSDR's EMEG) but not other protective comparison values (EPA's AEGL-1), the detection limit was chosen as a guideline for determining an orange-level response.

Red response level: The NIOSH STEL for benzene is an upper limit of exposure during a work-shift for prevention of any acute or long-term effects. EPA's AEGL-2 values are concentrations above which the general public, including sensitive individuals, could experience serious short-term or long-lasting health effects. The AEGL-2 is based on an animal study in which rats exposed to 4,000 ppm for 4 hours showed no evidence of reduced activity. EPA's AEGL-3 values are concentrations above which the general public could experience life-threatening health effects. Although NIOSH's STEL was established for worker exposure, it is the more conservative value and, therefore, was used to determine a red-level response value. The red-level response trigger of 0.5 ppm was determined by dividing the NIOSH STEL in half. This would provide agencies with the ability to confer on the situation and act to help prevent exposures of public health concern should the need arise.

Carbon Monoxide

Concentrations ≥ 9 ppm

- DNR staff determine data validity and 30-minute average concentration

- If 30-minute average concentration is ≥ 9 ppm (NAAQS 8-hr limit), coordinate “orange” response

Concentrations ≥ 13.5 ppm

- DNR staff determine data validity and a 10-minute average concentration
- If 10-minute average concentration is ≥ 13.5 ppm [EPA’s 8-hr AEGL-2 (27 ppm)], coordinate “red” response

**NAAQS 1-hr limit and NIOSH REL are 35 ppm.*

**EPA’s 8-hr AEGL-3 is 130 ppm.*

**EPA’s 10-minute AEGL-2 is 420 ppm.*

EPA’s 10-minute AEGL-3 is 1,700 ppm.

Orange response level: The NAAQS 8-hour limit was established for the protection of public health, including the health of sensitive individuals, and is currently the most health-protective guideline. Neither ATSDR nor EPA has established acute exposure guidelines for transient, “less severe” health effects.

Red response level: EPA’s AEGL-2 values are concentrations above which the general public, including sensitive individuals, could experience serious short-term or long-lasting health effects. EPA’s AEGL-3 values are concentrations above which the general public could experience life-threatening health effects. A NAAQS 1-hour limit has been established for the protection of public health, including sensitive individuals. The AEGL-2 established for 8-hour exposure is lower than the NAAQS 1-hour limit and, therefore, was used as a potentially more protective value for determining a red-level response value. The red-level response trigger of 13.5 ppm was determined by dividing the AEGL-2 in half. This would provide agencies with the ability to confer on the situation and act to help prevent exposures of public health concern should the need arise.

Table 1. Guideline Concentrations (ppm) for Acute Exposure to Chemicals in Air

Chemical	LDL ^a (ppm)	ATSDR Acute EMEG ^b	Acute Exposure Guidelines									
			EPA AEGL-1 ^c		EPA AEGL-2 ^c		EPA AEGL-3 ^c		NIOSH REL/ STEL ^d	EPA NAAQS ^e		
			8 hr	10 min	8 hr	10 min	8 hr	10 min		24 hr	8 hr	1 hr
Hydrogen Sulfide	0.001	0.07	Yellow 0.33	0.75	Red 17	41	31	76	10 (10 min)	ND	ND	ND
Sulfur Dioxide	0.1	0.01 ^f	Yellow 0.20	0.20	Red 0.75	0.75	9.6	30	2 (10 hr)	0.14	ND	0.075 ^f
Benzene	0.05	0.009 ^f	Yellow 9	130	Red 200	2,000	990	9,700	1 (15 min)	ND	ND	ND
Carbon Monoxide	0.1	ND	ND	ND	Red 27	420	130	1,700	35 (10 hr)	ND	Yellow 9	35

^aLower detection limit (LDL) of monitoring instrument

^bAgency for Toxic Substances and Disease Registry (ATSDR) Environmental Media Evaluation Guide (EMEG) for acute (<14 day) exposure. Concentrations equal to EMEGs are not expected to cause adverse health effects in the general population, including sensitive individuals including children and asthmatics.

^cEnvironmental Protection Agency (EPA) Acute Exposure Guideline Level (AEGL) for 8 hour and 10 minute exposure.

Concentrations that exceed AEGLs are predicted to cause transient, reversible health effects (AEGL-1), serious long-term or short-term effects (AEGL-2), or life-threatening effects (AEGL-3).

^dNational Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) or Short Term Exposure Limit (STEL) during work-shift.

^eNational Ambient Air Quality Standard for 24 hour, 8 hour, and 1 hour periods, for the protection of public health, including sensitive individuals such as children and asthmatics.

^fBelow detection limit capabilities.

ND = not determined

Table 2. Response Trigger Concentrations (ppm) of Landfill Gases in Ambient Air

Chemical	Response Level		
	Yellow 30-minute average concentration	Orange 30-minute average concentration	Red 10-minute average concentration (1/2 of red guideline concentration)
Hydrogen Sulfide	0.07 NA	0.33 0.33	5.0 17
Sulfur Dioxide	NA	0.1 0.20	0.375 0.75
Benzene	NA	0.05 9	0.5 200
Carbon Monoxide	NA	9.0 9	13.5 27

*Valid data: no sensor error and, according to meteorological conditions, site activity, data review, etc., exceedances are determined to be site-related

This value was revised

Response Levels (any response should be determined based on valid data, site conditions, meteorological conditions, planned site activities, etc.)

Green - show the yellow value - no adverse health effects expected

Yellow: Possible short-term, "less severe" health effects, such as headache, eye/nose/throat irritation. Sensitive individuals including asthmatics and people with other respiratory diseases should stay inside as much as possible, avoid outside strenuous activities, and seek medical attention for any acute symptoms.

Yellow - something like AEGL-1

Orange: Possible short-term, "less severe" health effects. All individuals should stay inside as much as possible, avoid outside strenuous activities, and seek medical attention for any acute symptoms. DNR contacts DHSS and other concerned agencies to coordinate a response, taking into consideration site conditions, meteorological conditions, planned site activities, etc.

Red - something like AEGL-2

Red: Prevention of possible long-term effects or serious short-term effects. DNR contacts DHSS and other concerned agencies to coordinate a response, taking into consideration site conditions, meteorological conditions, planned site activities, etc.

Standing Alert

Due to strong odors, individuals may experience undesirable, transient symptoms such as headache and nausea. Asthmatics and other sensitive individuals may be especially susceptible to strong odors. Also, although guideline values are protective of the general public including sensitive individuals such as children and asthmatics, certain individuals may experience health effects due to idiosyncratic response when concentrations are below those guideline levels. During periods of objectionable odor, sensitive individuals and persons with chronic respiratory diseases should limit time spent outdoors and seek medical advice for any acute symptoms.

Questions -

- 1) What are the analytes? Other landfill gases?
 - 2) Do we need values for all of TO-15 analytes? We need background data.
What are detection limits for all analytes? How sensitive is sampling equipment?
 - 3) What is time frame of exposure that we're protecting for? e.g., 30 minutes, 8-hr, 14 days, etc.
 - 4) How do we define Yellow, Orange, and Red?
 - 5) What is monitoring plan
- Use Best Available Science, not necessarily lowest value
 - Want consistent hierarchy and consistent time-frame

- chronic + subchronic animal vs. human data

- ATSDR - subchronic

1) What are the analytes?

2) What exposure time-frame are we protecting for?

3) What are reporting limits of instruments